Hierarchy, Scale, and the Goldilocks Principle: Getting Indicators Just Right

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# The Tale of Goldilocks

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- After she'd eaten the three bears' breakfasts Goldilocks was feeling a little tired, so she walked into the living room where she saw three chairs.
- Goldilocks sat in the first chair to rest her feet. "This chair is too big!" she exclaimed.
- So she sat in the second chair." This chair is too big, too!" she whined.
- So she tried the last and smallest chair. "Ahhh, this chair is just right," she sighed. But just as she settled down it broke into pieces!
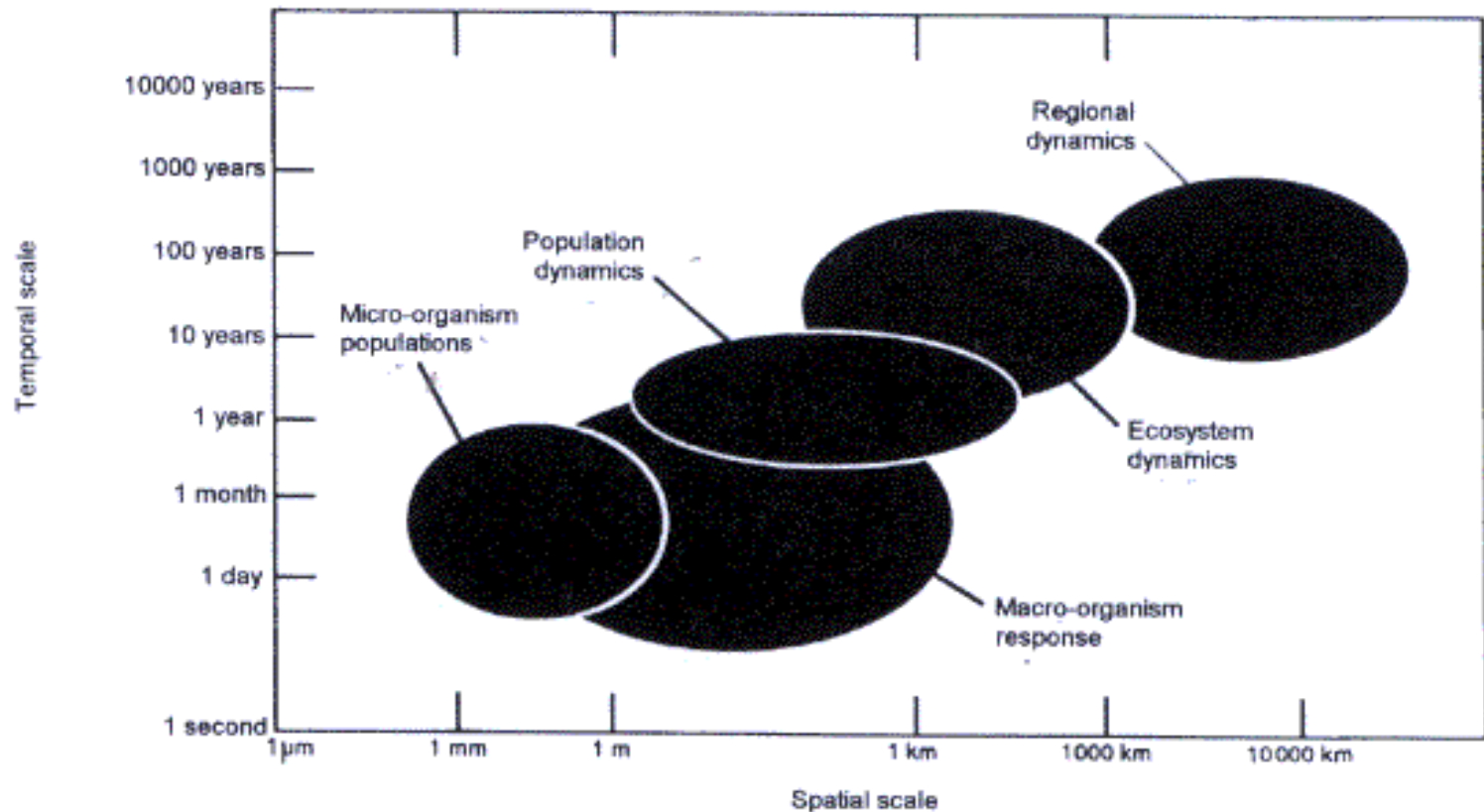
Hierarchy Theory

Boundary Conditions
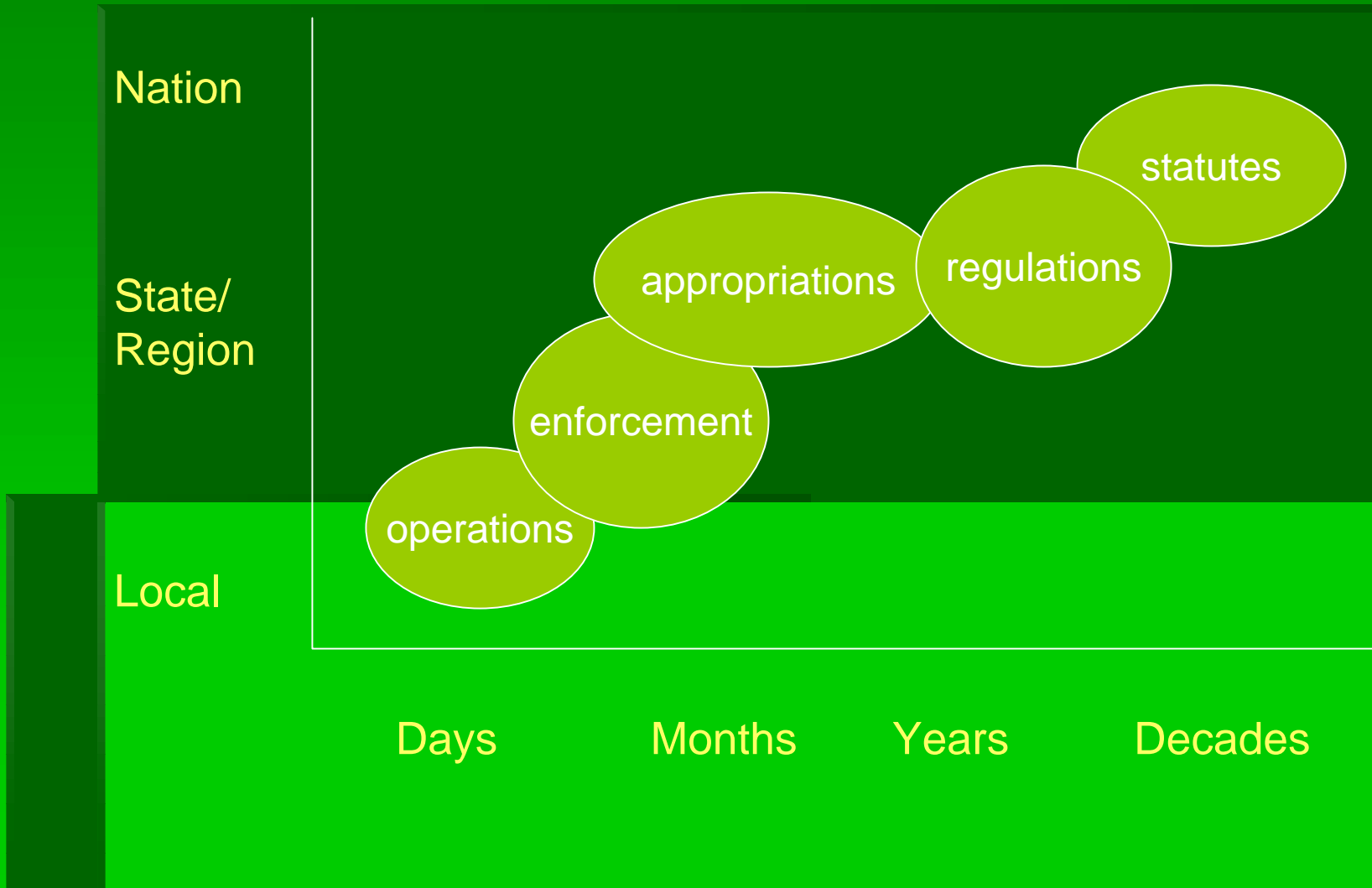
Focal Level

Initiating Conditions
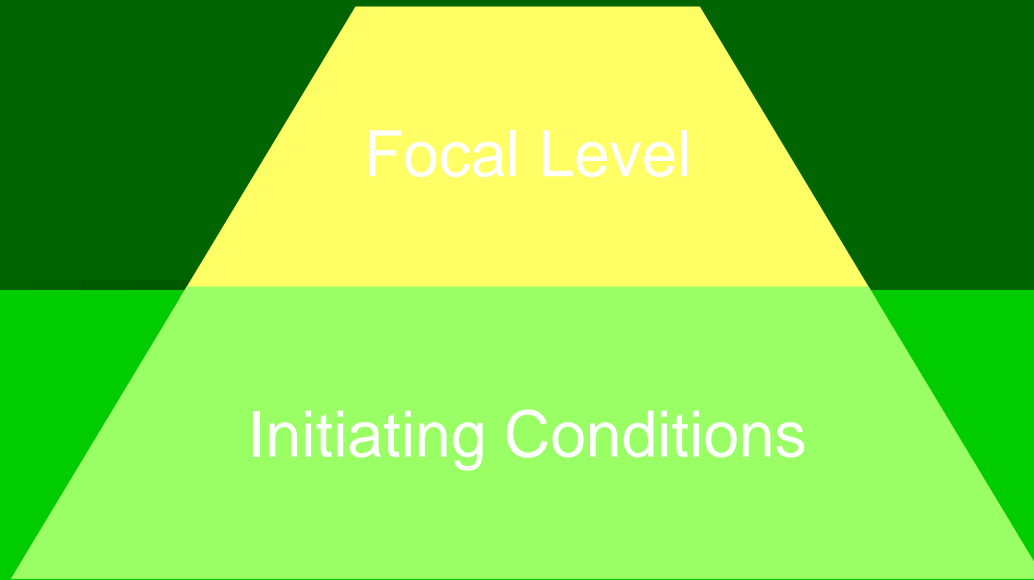
Hierarchy

- **Boundary conditions** – Larger, slower entities and processes that constrain the focal level

- **Focal level** – The entities and processes of concern

- **Initiating conditions** – Smaller, faster entities and processes that enable the focal level

Hierarchy and Scale in Ecology

Hierarchy and Scale in Policy

Some Drinking Water Examples

- Questions:
  - Local - Is my tap water safe to drink?
  - State/Regional - Does my state or EPA need to invest more money in monitoring and enforcement or on upgrading water treatment and distribution systems?
  - National – Do we need new regulations or a major change in the Safe Drinking Water Act?
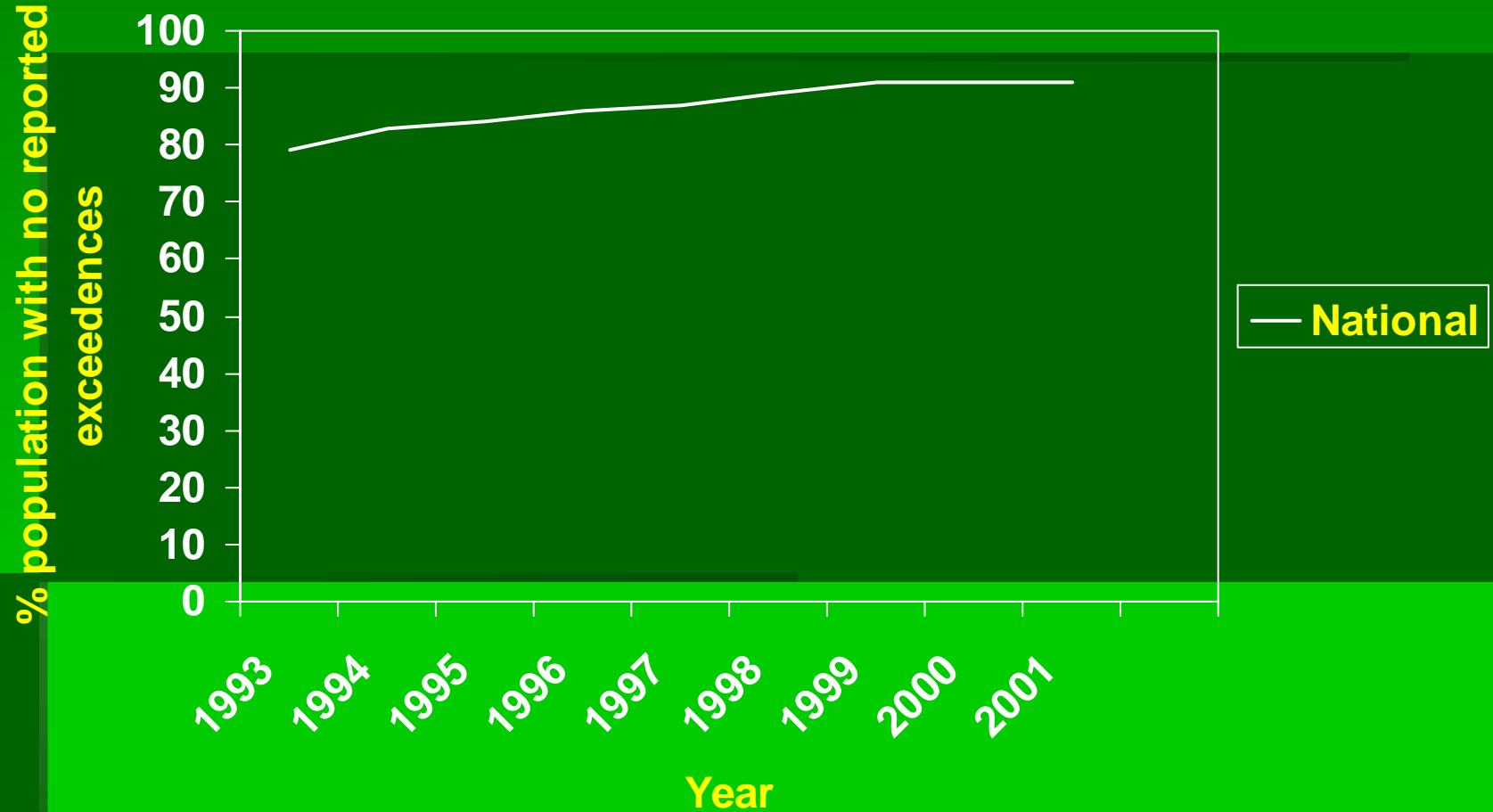
Some Drinking Water Examples

- Is my water safe to drink?
  - Survey of tap water.
- Does State or Region x need to step up enforcement of drinking water regulations?
  - State or Regional statistics on violations of health-based standards.
- Do we need a major change in SDWA, regulations, or federal appropriations?
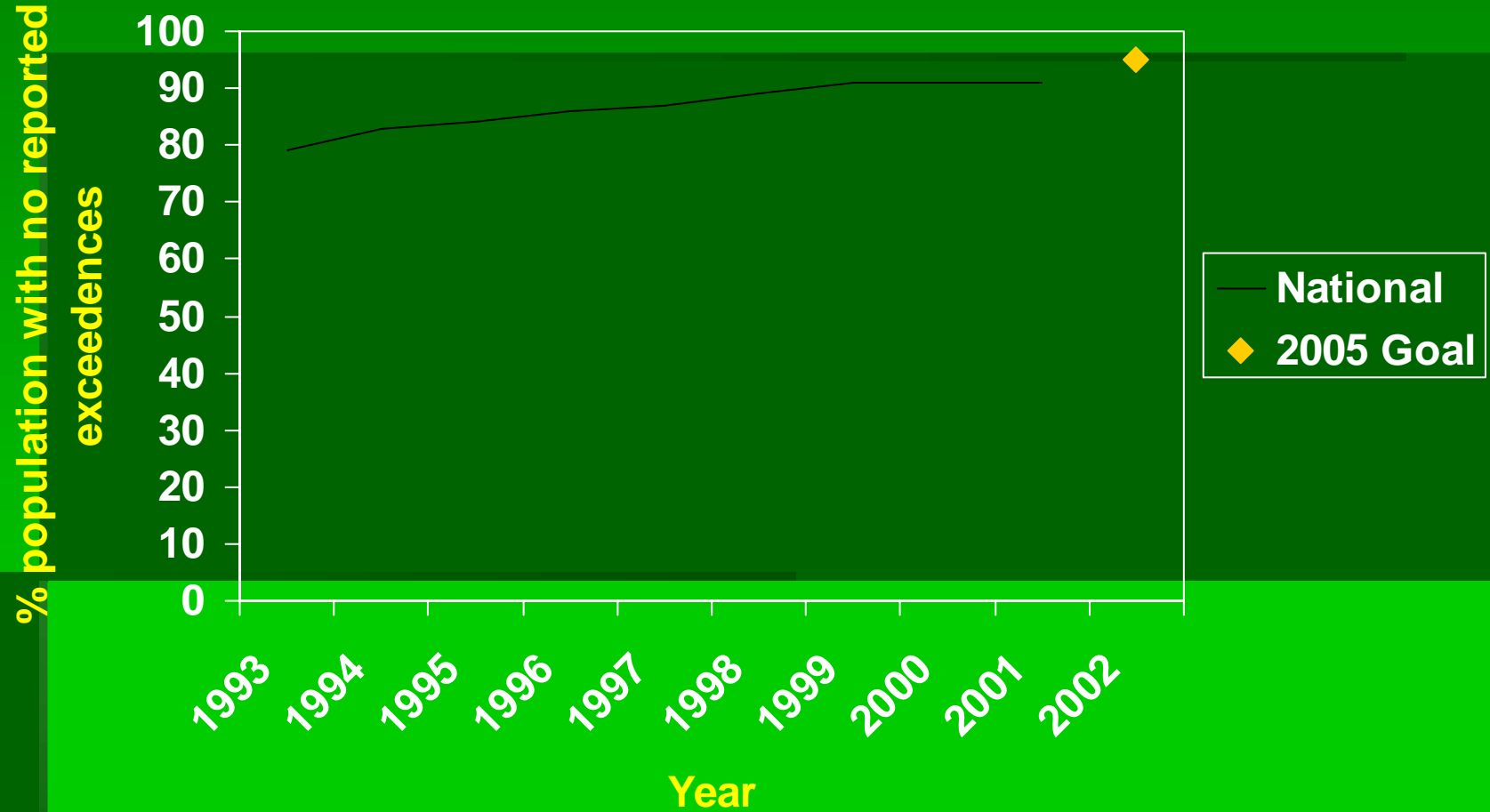 - National statistics on violations of health-based standards.

Drinking water case study

Source: *Factoids: Drinking Water and Groundwater Statistics for 2001,* US EPA Office of Water, EPA 815-K-02-004

Trends in health based violations at Community Water Systems

Trends in health based violations at Community Water Systems

- **— National**
- **♦ 2005 Goal**

% population with no reported exceedences

100
90
80
70
60
50
40
30
20
10
0

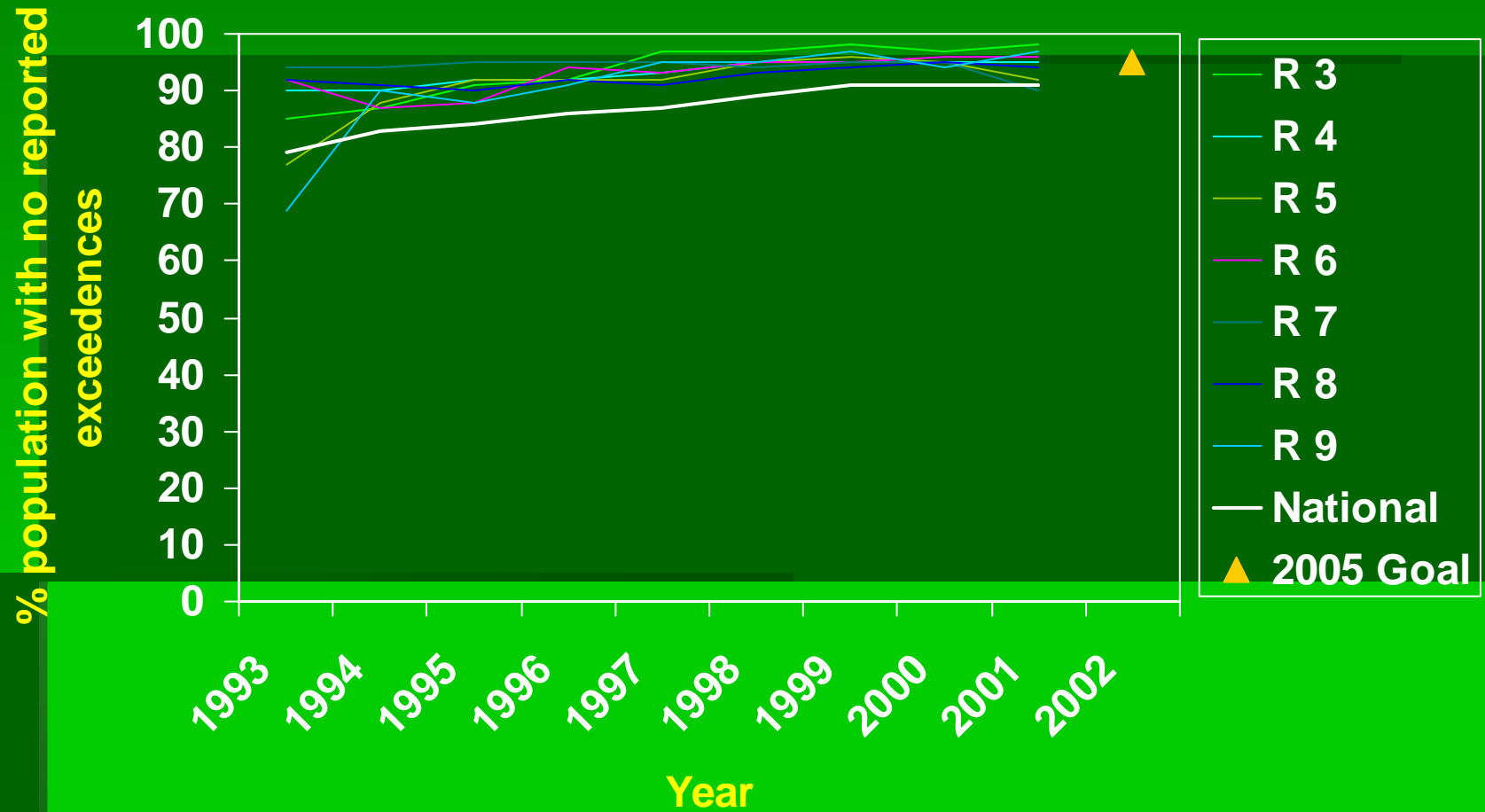1993 1994 1995 1996 1997 1998 1999 2000 2001 2002

Year

Trends in health based violations at Community Water Systems

Trends in health based violations at Community Water Systems

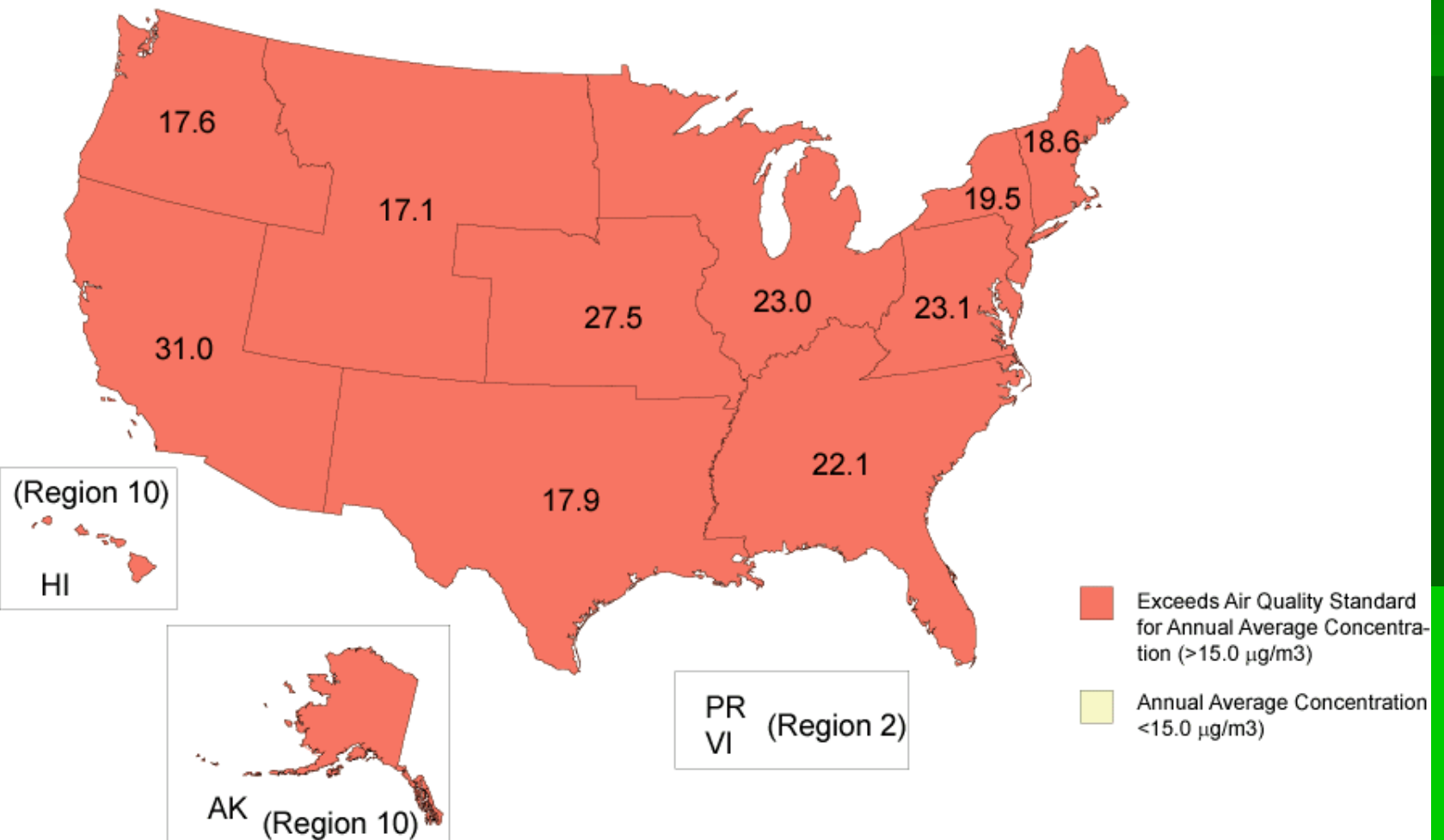Trends in health based violations at Community Water Systems
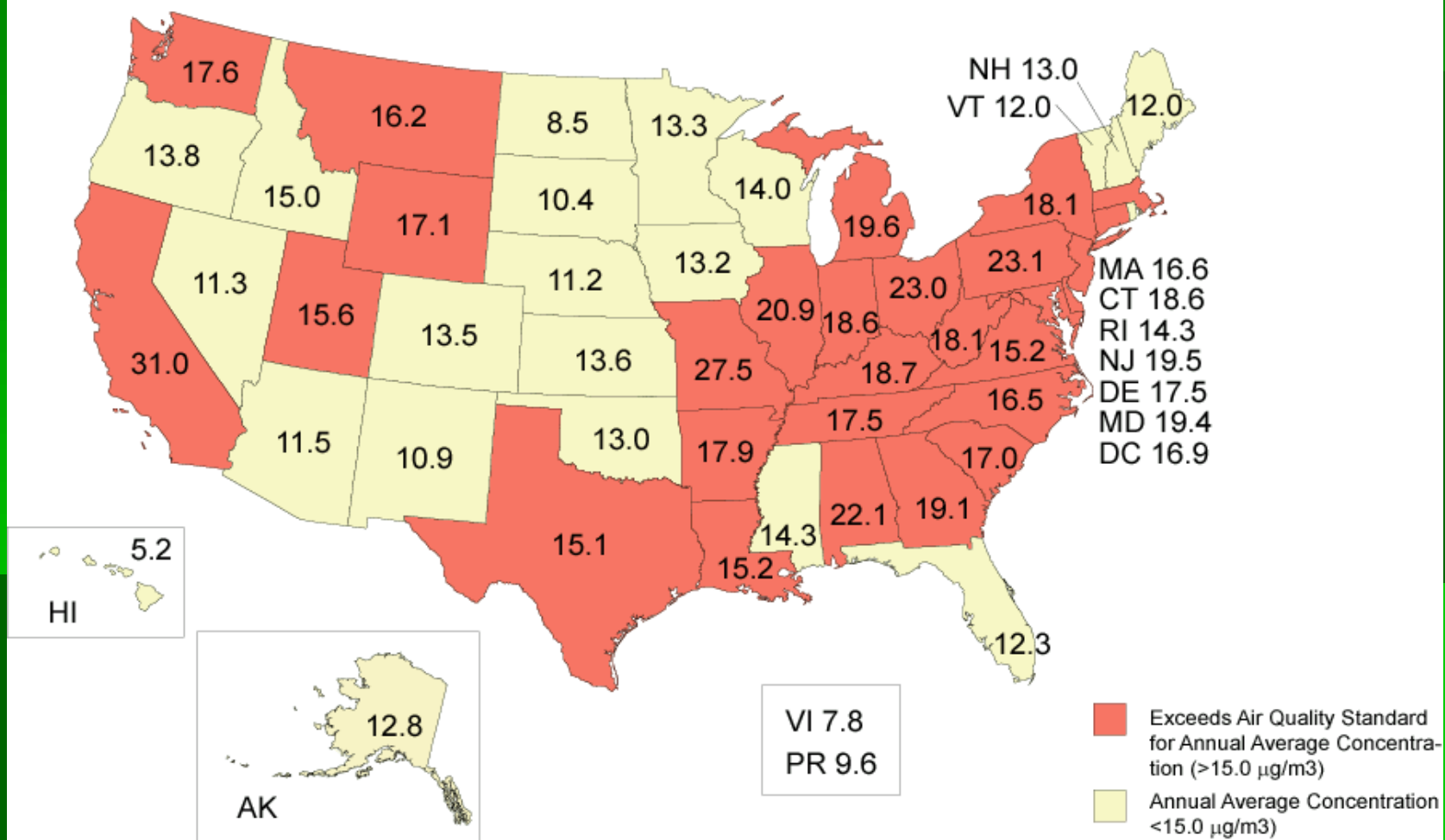
Air quality case study – Particulate Matter

Source: Air Data - 2001 U.S. EPA
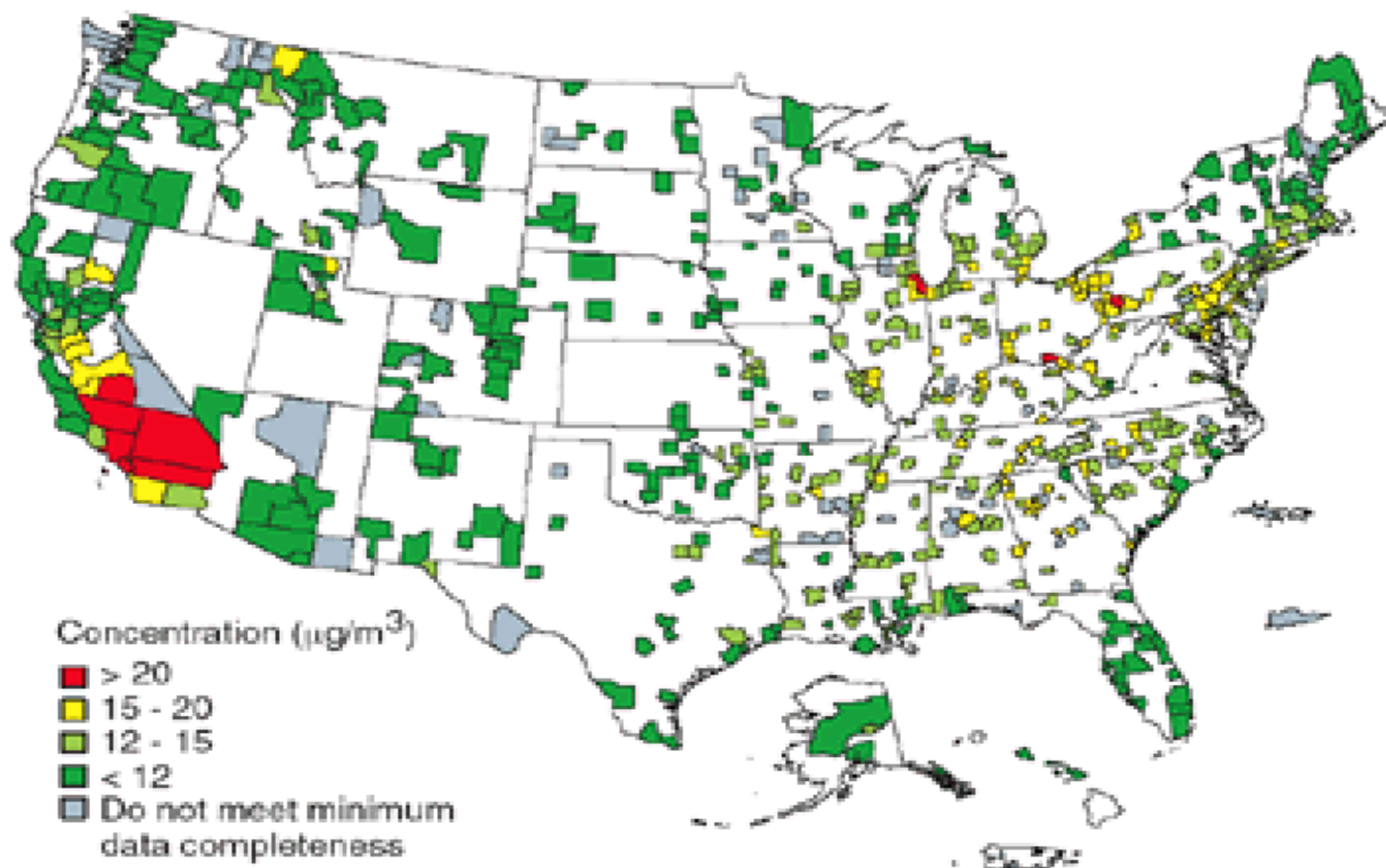
www.epa.gov/air/data/geocel.html

Indicator: Ambient concentration of PM2.5 (μg/m3), by EPA Region

17.6

17.1

18.6

19.5

23.0

23.1

31.0

27.5

(Region 10)

HI

22.1

17.9

PR
VI   (Region 2)

AK (Region 10)

Exceeds Air Quality Standard for Annual Average Concentration (>15.0 μg/m3)

Annual Average Concentration <15.0 μg/m3

2001 mean   http://www.epa.gov/air/data/geosel.html AirData

Indicator: Ambient concentration of PM2.5 (μg/m3), by state

2001 mean http://www.epa.gov/air/data/geosel.html AirData

Indicator: Ambient concentration of PM2.5 (mg/m3)

Concentration ($\mu g/m^3$)

- ■ > 20
- ■ 15 - 20
- ■ 12 - 15
- ■ < 12
- □ Do not meet minimum data completeness

Source: U.S. EPA AIRS databases as of 7/8/02.
Minimum 11 samples per calendar quarter required.

http://www.epa.gov/oar/aqtrnd01/pmatter.html 2001 Status and Trends report
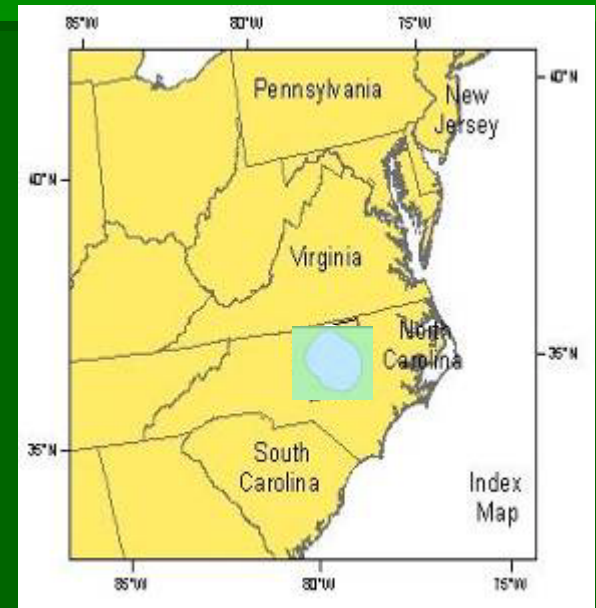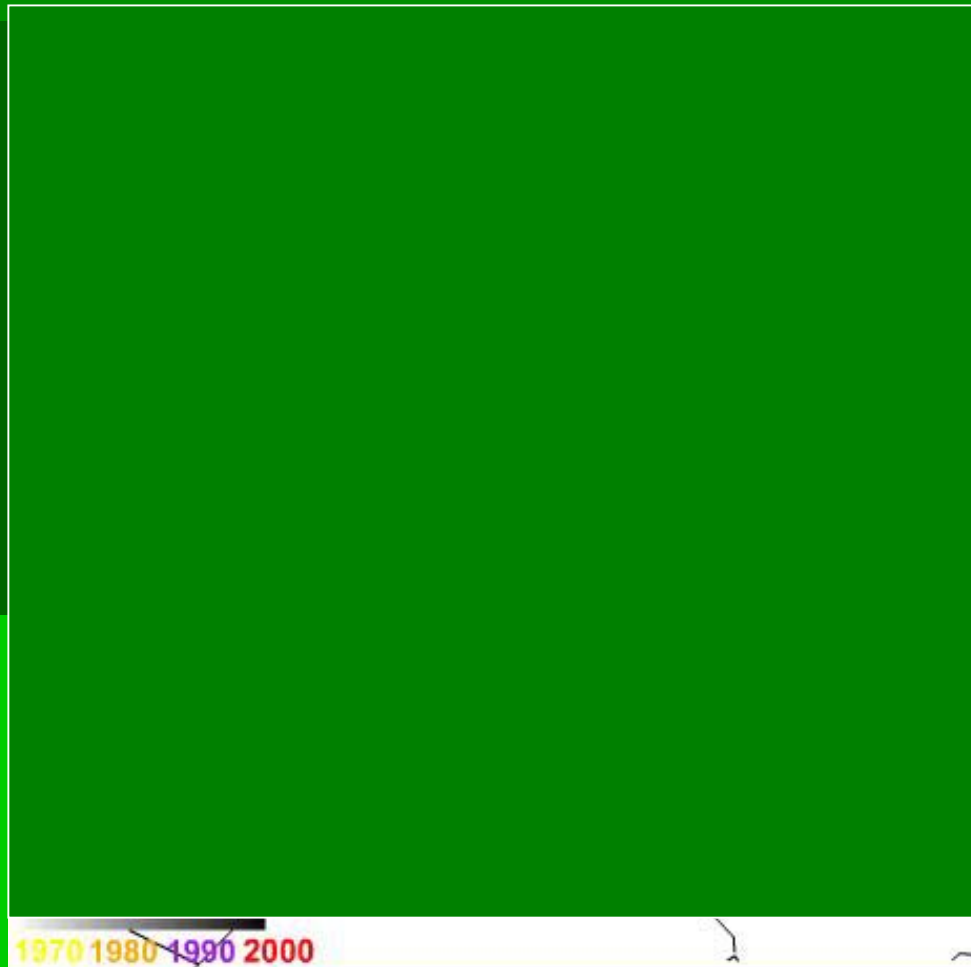
National Stream Survey Example

West Virginia: WVSCI
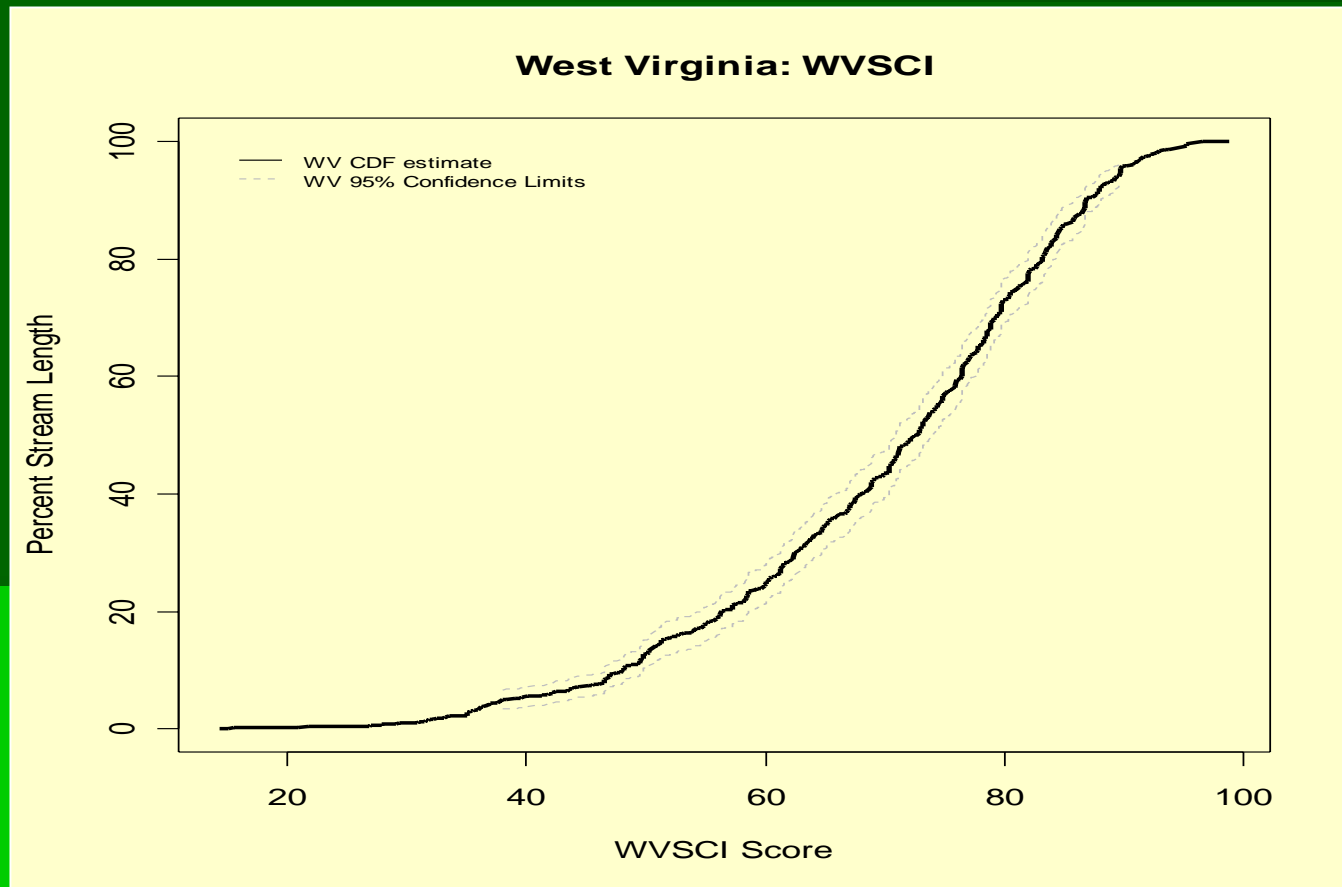
Wetland conversion example

Exhibit 2-8: Non-Federal wetland losses and gains and reasons for conversion, 1992–1997

coverage does not include Alaska, Hawaii or Puerto Rico
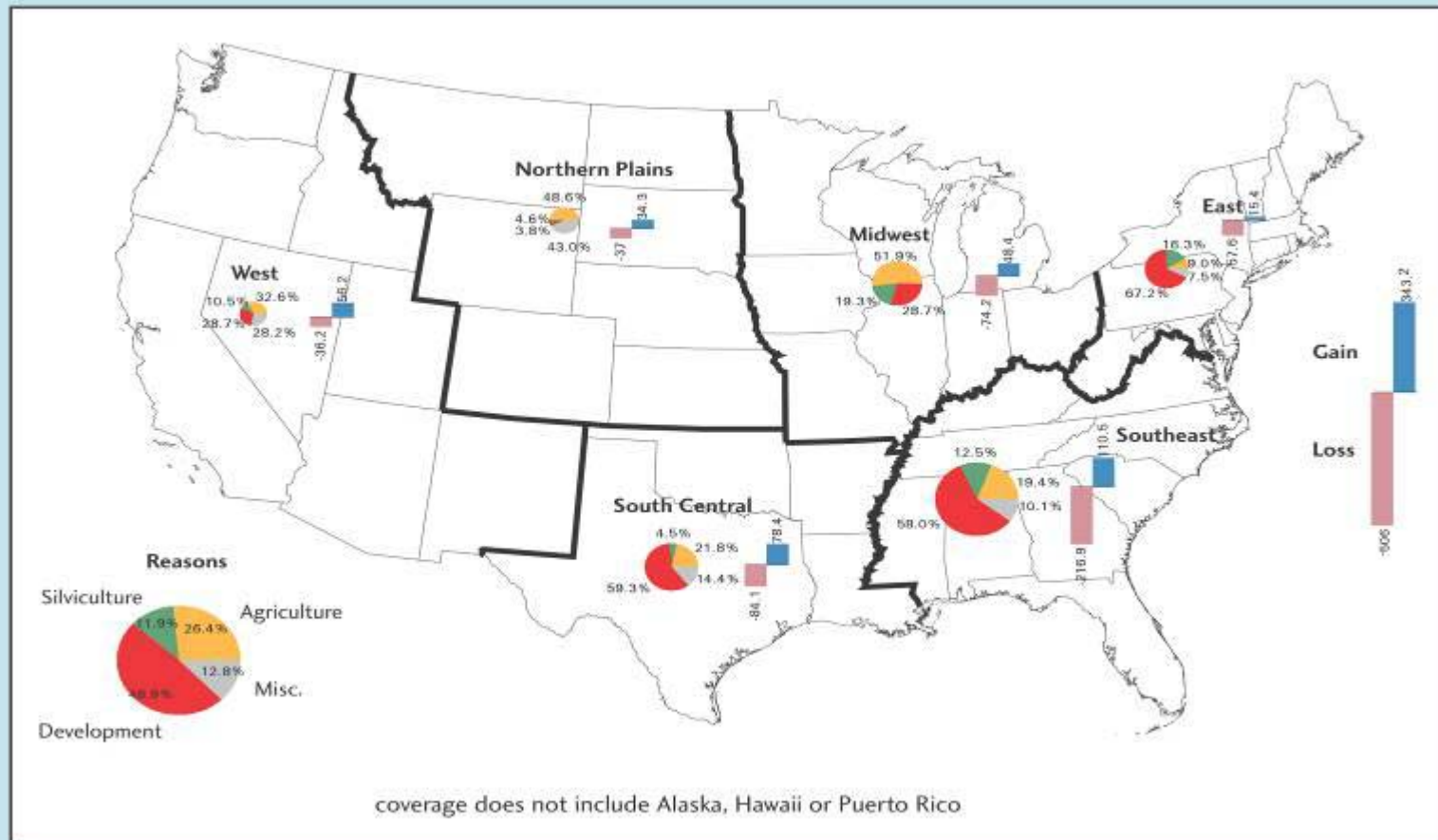
Source: Summary Report: 1997 National Resources Inventory (Revised December 2000). 2000.

RDU Urban Land Use Example

1970 1980 1990 2000
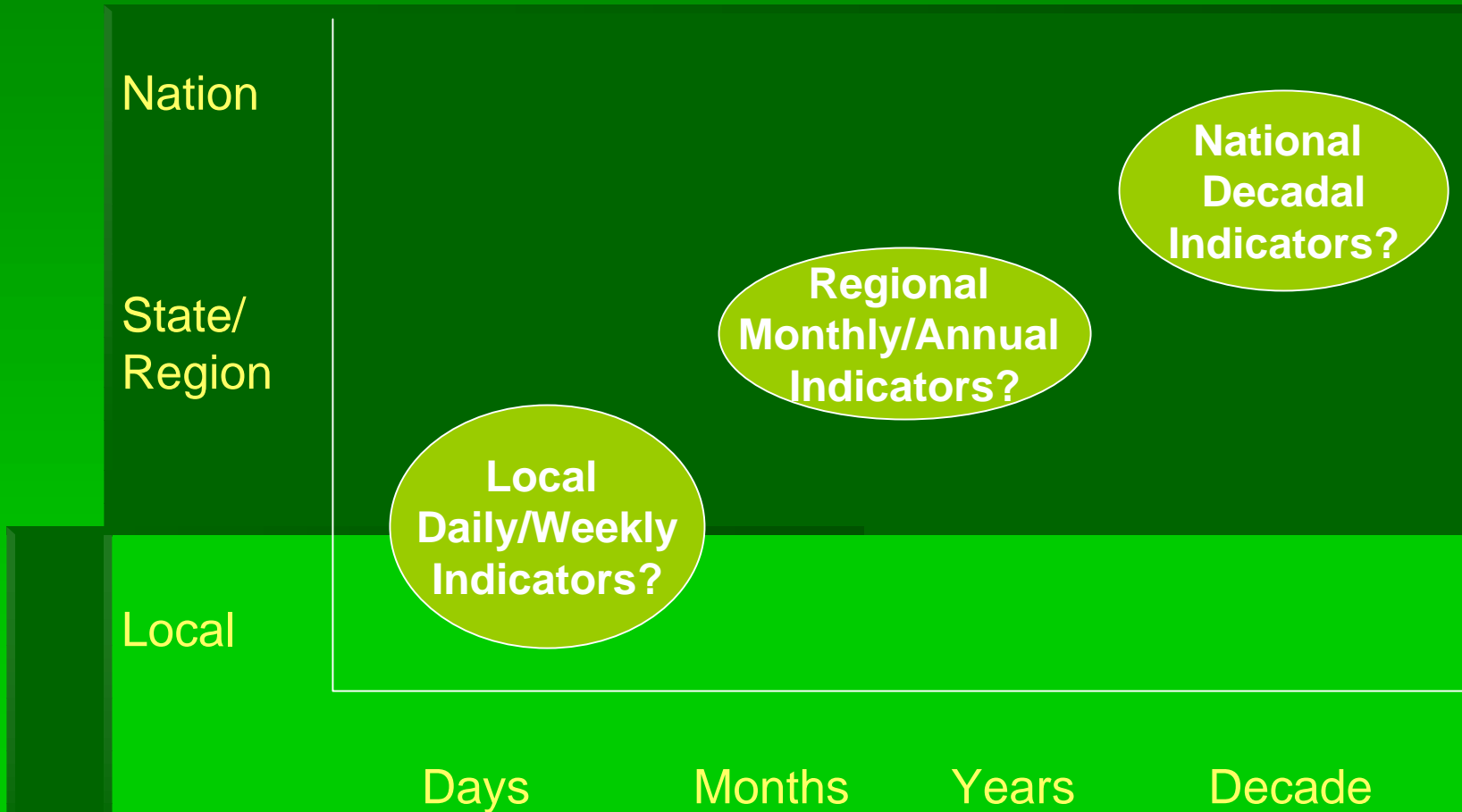
The Goldilocks Principle

- Don't pick indicators too large and slow
- Don't pick indicators that are too small and fast
- Pick indicators that are "just right"

A possible model for indicator scale?

How can we get indicators just right?

- Consider where the performance or policy issue lies in the hierarchy.

- Develop indicators with time and space scales appropriate to the position in the hierarchy.

- Use probability distributions or graphics rather than single statistics to reconcile small scale data with large scale indicators

- Be careful about extreme values

But be careful about extreme values!